

standard conditions for temperature and pressure (0 °C and 101.3 kPa), and these conditions must be used consistently throughout all calculations.

(b) *Engine test conditions.* Measure the absolute temperature (designated as T and expressed in Kelvin) of the engine air at the inlet to the engine, and the dry atmospheric pressure (designated as p and expressed in kPa), and determine the parameter f according to the following provisions:

(1) Naturally aspirated and mechanically supercharged engines:

$$f = \frac{99}{p_s} \times \left(\frac{T}{298} \right)^{0.7}$$

(2) Turbocharged engine with or without cooling of inlet air:

$$f = \left(\frac{99}{p_s} \right)^{0.7} \times \left(\frac{T}{298} \right)^{1.5}$$

(c) For a test to be recognized as valid, the parameter f shall be between the limits as shown below:

$$0.98 < f < 1.02$$

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

APPENDIX A TO SUBPART D OF PART 89— TABLES

TABLE 1—ABBREVIATIONS USED IN SUBPART D

CLD	Chemiluminescent detector.
CO	Carbon monoxide.
CO ₂	Carbon dioxide.
HC	Hydrocarbons.
HCLD	Heated chemiluminescent detector.
HFID	Heated flame ionization detector.
GC	Gas chromatograph.
NDIR	Non-dispersive infra-red analyzer.
NIST	National Institute for Standards and Testing.
NO	Nitric Oxide.
NO ₂	Nitrogen Dioxide.
NO _x	Oxides of nitrogen.
O ₂	Oxygen.

TABLE 2—SYMBOLS USED IN SUBPARTS D AND E

Symbol	Term	Unit
conc	Concentration (ppm by volume)	ppm
f	Engine specific parameter considering atmospheric conditions	
F_{FCB}	Fuel specific factor for the carbon balance calculation	
F_{FD}	Fuel specific factor for exhaust flow calculation on dry basis	
F_{FH}	Fuel specific factor representing the hydrogen to carbon ratio	
F_{FW}	Fuel specific factor for exhaust flow calculation on wet basis	
FR	Rate of fuel consumed	g/h
G_{AIRW}	Intake air mass flow rate on wet basis	kg/h
G_{AIRD}	Intake air mass flow rate on dry basis	kg/h
G_{EXHW}	Exhaust gas mass flow rate on wet basis	kg/h
G_{Fuel}	Fuel mass flow rate	kg/h
H	Absolute humidity (water content related to dry air)	g/kg
i	Subscript denoting an individual mode	
K_H	Humidity correction factor	
L	Percent torque related to maximum torque for the test mode	%
mass	Pollutant mass flow	g/h
$n_{d,i}$	Engine speed (average at the i 'th mode during the cycle)	1/min
P_s	Dry atmospheric pressure	kPa
P_d	Test ambient saturation vapor pressure at ambient temperature	kPa
P	Observed brake power output uncorrected	kW
P_{AUX}	Declared total power absorbed by auxiliaries fitted for the test	kW
P_M	Maximum power measured at the test speed under test conditions	kW
P_i	$P_i = P_{M,i} + P_{AUX,i}$	
P_B	Total barometric pressure (average of the pre-test and post-test values)	kPa
P_v	Saturation pressure at dew point temperature	kPa
R_a	Relative humidity of the ambient air	%
S	Dynamometer setting	kW
T	Absolute temperature at air inlet	K
T_{be}	Air temperature after the charge air cooler (if applicable) (average)	K
T_{clout}	Coolant temperature outlet (average)	K
T_{dpd}	Absolute dewpoint temperature	K
$T_{d,i}$	Torque (average at the i 'th mode during the cycle)	N-m
T_{SC}	Temperature of the intercooled air	K
T_{ref}	Reference temperature	K
V_{EXHD}	Exhaust gas volume flow rate on dry basis	m ³ /h
V_{AIRW}	Intake air volume flow rate on wet basis	m ³ /h
P_B	Total barometric pressure	kPa
V_{EXHW}	Exhaust gas volume flow rate on wet basis	m ³ /h

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TABLE 2—SYMBOLS USED IN SUBPARTS D AND E—Continued

Symbol	Term	Unit
WF	Weighing factor	
WF _E	Effective weighing factor	

TABLE 3—MEASUREMENT ACCURACY AND CALIBRATION FREQUENCY

No.	Item	Calibration accuracy ¹	Calibration frequency
1	Engine speed	±2%	30 days.
2	Torque	Larger of ±2% of point or ±1% of engine maximum.	30 days.
3	Fuel consumption (raw measurement)	±2% of engine maximum	30 days.
4	Air consumption (raw measurement)	±2% of engine maximum	As required.
5	Coolant temperature	±2 °K	As required.
6	Lubricant temperature	±2 °K	As required.
7	Exhaust backpressure	±1.0% of engine maximum	As required.
8	Inlet depression	1.0% of engine maximum	As required.
9	Exhaust gas temperature	±15 °K	As required.
10	Air inlet temperature (combustion air)	±2 °K	As required.
11	Atmospheric pressure	±0.5%	As required.
12	Humidity (combustion air) (g of H ₂ O/Kg of dry air)	±0.5	As required.
13	Fuel temperature	±2 °K	As required.
14	Temperature with regard to dilution tunnel	±2 °K	As required.
15	Dilution air humidity (g of H ₂ O/Kg of dry air)	±0.5	As required.
16	HC analyzer	±2%	Monthly or as required.
17	CO analyzer	±2%	Once per 60 days or as required.
18	NO _x analyzer	±2%	Monthly or as required.
19	Methane analyzer	±2%	Monthly or as required.
20	NO _x converter efficiency check	90%	Monthly.
21	CO ₂ analyzer	±2%	Once per 60 days or as required.

¹ All accuracy requirements pertain to the final recorded value which is inclusive of the data acquisition system.

TABLE 4—FEDERAL TEST FUEL SPECIFICATIONS

Item	Procedure (ASTM) ¹	Value (type 2–D)
Cetane	D613–95	40–48
Distillation Range:		
IBP, °C	D86–97	171–204
10% point, °C	86–97	204–238
50% point, °C	86–97	243–282
90% point, °C	86–97	293–332
EP, °C	86–97	321–366
Gravity, API	D287–92	32–37
Total Sulfur, %mass	D129–95 or D2622–98	0.03–0.40
Hydrocarbon composition:		
Aromatics, %vol	D1319–98 or D5186–96	≥ 10
Paraffins, Naphthenes, Olefins	D1319–98	(³)
Flash Point, °C (minimum)	D93–09	54
Viscosity @ 38 °C, centistokes	D445–09	2.0–3.2

¹ All ASTM procedures in this table have been incorporated by reference. See § 89.6.

² Minimum.

³ Remainder.

[63 FR 57013, Oct. 23, 1998, as amended at 77 FR 2461, Jan. 18, 2012]